

2. The semiconductor device according to claim 1, wherein the groove has a width of 3 μm to 20 μm , the groove has a depth of 2 μm to 10 μm , the second semiconductor region has a thickness of 40 μm to 140 μm , and the second semiconductor region has a resistivity of 10 Ωcm to 150 Ωcm .

3. The semiconductor device according to claim 1, wherein an interface between the second semiconductor region and the third semiconductor region is located between the adjacent groove, and

the interface in a region far from the groove is located closer to the first semiconductor region than the interface in regions adjoining the groove is.

4. The semiconductor device according to claim 1, wherein a length of the bottom electrode in a widthwise direction of the groove is larger than the gap between the adjacent groove.

5. The semiconductor device according to claim 1, wherein the width of the groove is larger than a depth of the groove, and

the width of the groove is 3 to 20 μm .

6. The semiconductor device according to claim 1, wherein the bottom electrode is arranged to face 70% or more of the bottom surface of the groove.

7. A semiconductor device comprising:

a groove formed on a front surface of a semiconductor substrate;

a gate electrode arranged in contact with an oxide film formed on an inner surface of the groove;

a first main electrode formed on the front surface of the semiconductor substrate; and

a second main electrode formed on a back surface of the semiconductor substrate;

switching of an operating current flowing between the first main electrode and the second main electrode being controlled by a voltage applied to the gate electrode,

wherein the gate electrode is formed on both side surfaces of the groove, and is at least partially removed from a bottom surface of the groove,

a width of the groove is larger than a depth of the groove,

a bottom electrode separated from the gate electrode is arranged on a portion of the oxide film at the bottom surface of the groove from which the gate electrode is removed, and

the bottom electrode is electrically connected to the first main electrode.

8. The semiconductor device according to claim 7, wherein the bottom electrode comprises a body arranged on the bottom surface of the groove, and a connection portion electrically connecting the body to the second main electrode,

wherein, in plan view, the body is formed in a strip shape and extends in the extending direction of the groove, and the connection portion extends in the depth direction of the groove, and

a dimension of the body in the depth direction of the groove is larger than a dimension of the connection portion in the depth direction of the groove.

9. The semiconductor device according to claim 1, wherein the groove include groove arranged side by side, the adjacent groove are connected to each other through the connection groove,

the connection groove is formed extending from the top surface of the fourth semiconductor region and reaching the second semiconductor region through the third semiconductor region, and the width of the connection groove is larger than the gap between the adjacent groove,

the bottom electrode includes the body arranged on the bottom surface of the groove, and the connection portion electrically connecting the body to the second main electrode,

in plan view, the body is formed in the strip shape and extends in the extending direction of the groove, and the connection portion extends in the depth direction of the groove,

the body is arranged inside the connection groove, and a width of the connection portion is larger than a width of the body.

10. The semiconductor device according to claim 1, wherein the groove includes groove arranged side by side, the adjacent groove are connected to each other through the connection groove,

the connection groove is formed extending from the top surface of the fourth semiconductor region and reaching the second semiconductor region through the third semiconductor region, and

the control electrodes are connected to each other on an inner side surface of the connection groove.

11. The semiconductor device according to claim 1, wherein

the bottom electrode includes the body arranged on the bottom surface of the groove, and the connection portion electrically connecting the body to the second main electrode,

in plan view, the body is formed in the strip shape and extends in the extending direction of the groove, and the connection portion extends in the depth direction of the groove,

the groove includes groove arranged side by side, the adjacent groove are connected to each other through the connection groove,

the connection groove is formed extending from the top surface of the fourth semiconductor region and reaching the second semiconductor region through the third semiconductor region,

an end of the body is arranged inside the connection groove,

the control electrode is connected to a bus line through a connection portion of the control electrode,

the connection portion of the control electrode includes:

a first portion formed on an inner side surface of the connection groove,

a second portion connected to the first portion, and formed on a bottom surface of the connection groove to extend between the ends of the bodies adjacent to each other, and

a third portion connected to the second portion and formed on an outer side surface of the connection groove, and

a dimension of the second portion in the depth direction of the groove is smaller than a dimension of the control electrode in the depth direction of the groove.

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